Designation: B591 – 20

Standard Specification for Copper-Zinc-Tin and Copper-Zinc-Tin-Iron-Nickel Alloys Plate, Sheet, Strip, and Rolled Bar[1]

This standard is issued under the fixed designation B591; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification establishes the requirements for specified copper-zinc-tin alloys and copper-zinc-tin-iron-nickel alloys plate, sheet, strip, and rolled bar. The alloys and nominal compositions are as follows:

Copper Alloy UNS No.	Copper, %	Tin, %	Zinc, %	Phos., %	Iron, %	Nickel, %
C40500	95	1	4			
C40810	95.5	2.0	2.2	0.03	0.1	0.15
C40850	95.5	3.0	1.3	0.1	0.1	0.1
C40860	94.8	2.0	3	0.03	0.03	0.1
C41100	91	0.5	8.5			
C41300	91	1	8			
C41500	91	2	7			
C42200	87	1	12			
C42500	88	2	10			
C42520	89.8	2.0	8	0.1	0.1	0.1
C43000	85	2	13			
C43400	85	0.7	14.3			

1.2 *Units*—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.2.1 *Exception*—Average grain size in Table 3 is stated in SI units.

1.3 The following safety hazard caveat pertains only to the test method(s) described in this specification:

1.3.1 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B248 Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar

B601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast

B846 Terminology for Copper and Copper Alloys

E8/E8M Test Methods for Tension Testing of Metallic Materials

E18 Test Methods for Rockwell Hardness of Metallic Materials

E62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods) (Withdrawn 2010)[3]

E112 Test Methods for Determining Average Grain Size

E478 Test Methods for Chemical Analysis of Copper Alloys

3. General Requirements

3.1 The following sections of Specification B248 constitute a part of this specification:

3.1.1 Terminology—Definitions;
3.1.2 Workmanship, Finish, and Appearance;
3.1.3 Sampling;
3.1.4 Number of Tests and Retests;
3.1.5 Specimen Preparation;
3.1.6 Test Methods—except for chemical analysis;
3.1.7 Significance of Numerical Limits;
3.1.8 Inspection;
3.1.9 Rejection and Rehearing;
3.1.10 Certification;
3.1.11 Test Reports (Mill);
3.1.12 Packaging and Package Marking; and

[1] This specification is under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.01 on Plate, Sheet, and Strip.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

***A Summary of Changes section appears at the end of this standard**

3.1.13 Supplementary Requirements.

3.2 In addition, when a section with a title identical to that referenced in 3.1 appears in this specification, it contains additional requirements, which supplement those appearing in Specification B248.

4. Terminology

4.1 For definitions of terms related to copper and copper alloys, refer to Terminology B846.

5. Ordering Information

5.1 Include the following specified choices when placing orders for product under this specification, as applicable:

5.1.1 ASTM designation and year of issue (for example, B591 – XX);

5.1.2 Copper [Alloy] UNS No. Designation (for example, C42500);

5.1.3 Temper (see Section 8);

5.1.4 Dimensions, that is, thickness, width, length, and so forth (see Section 12);

5.1.5 Form: plate, sheet, strip, or rolled bar;

5.1.6 How furnished: coils, specific or stock lengths, with or without ends;

5.1.7 Quantity: total weight each form, temper, and size; and

5.1.8 Intended application.

5.2 The following options are available but may not be included unless specified at the time of placing of the order when required:

5.2.1 Type of edge: slit, sheared, sawed, square corners, round corners, rounded edges, or full rounded edges;

5.2.2 Width and straightness tolerances (see Section 12);

5.2.3 Heat Identification or traceability details (see 6.1.2);

5.2.4 Certification; and

5.2.5 Mill Test Report.

5.2.6 If product is purchased for agencies of the U.S. Government, see Section 11 of this specification and the Supplementary Requirements section of Specification B248 for additional requirements, if specified.

6. Materials and Manufacture

6.1 *Material:*

6.1.1 The material of manufacture shall be a form (cast bar, cake, or slab) of Copper Alloy UNS No. C40500, C40810, C40850, C40860, C41100, C41300, C41500, C42200, C42500, C42520, C43000, or C43400 of such purity and soundness as to be suitable for processing into products prescribed herein.

6.1.2 When specified in the contract or purchase order that heat identification or traceability is required, the purchaser shall specify the details desired.

NOTE 1—Due to the discontinuous nature of the processing of castings into wrought products, it is not always practical to identify a specific casting analysis with a specific quantity of finished material.

6.2 *Manufacture:*

6.2.1 The product shall be manufactured by such hot working, cold working, and annealing processes as to produce a uniform wrought structure in the finished product.

6.2.2 The product shall be hot or cold worked to the finished size and subsequently annealed, when required, to meet the temper properties specified.

6.2.3 *Edges*—Slit edges shall be furnished unless otherwise specified in the contract or purchase order.

7. Chemical Composition

7.1 The material shall conform to the chemical compositional requirements specified in Table 1 for the copper alloy UNS No. designation specified in the ordering information.

7.1.1 These composition limits do not preclude the presence of other elements. By agreement between the manufacturer and purchaser, limits may be established and analysis required for unnamed elements.

7.2 For alloys in which zinc is listed as "remainder," either copper or zinc may be taken as the difference between the sum of the results for all elements determined and 100 %. When all elements in Table 1 are determined, the sum of the results shall be 99.7 % min.

8. Temper

8.1 The standard tempers for products described in this specification are given in Table 2 and Table 3.

8.1.1 *Hot Rolled Temper (M20).*

8.1.2 *Cold Rolled Tempers H01 to H10*—Special tempers not listed in this specification are subject to agreement between the manufacturer and the purchaser.

TABLE 1 Chemical Requirements

Copper Alloy UNS No.	Composition, % max (Unless Shown as a Range)						
	Copper	Tin	Lead	Iron	Phosphorus	Nickel	Zinc
C40500	94.0-96.0	0.7-1.3	0.05	0.05	. . .	. . .	remainder
C40810	94.5-96.5	1.8-2.2	0.05	0.08-0.12	0.028-0.04	0.11-0.20	remainder
C40850	94.5-96.5	2.6-4.0	0.05	0.05-0.20	0.01-0.20	0.05-0.20	remainder
C40860	94.0-96.0	1.7-2.3	0.05	0.01-0.05	0.02-0.04	0.05-0.20	remainder
C41100	89.0-92.0	0.30-0.7	0.09	0.05	. . .	. . .	remainder
C41300	89.0-93.0	0.7-1.3	0.09	0.05	. . .	. . .	remainder
C41500	89.0-93.0	1.5-2.2	0.09	0.05	. . .	. . .	remainder
C42200	86.0-89.0	0.8-1.4	0.05	0.05	0.35	. . .	remainder
C42500	87.0-90.0	1.5-3.0	0.05	0.05	0.35	. . .	remainder
C42520	88.0-91.0	1.5-3.0	0.05	0.05-0.20	0.01-0.20	0.05-0.20	remainder
C43000	84.0-87.0	1.7-2.7	0.09	0.05	. . .	. . .	remainder
C43400	84.0-87.0	0.40-1.0	0.05	0.05	. . .	. . .	remainder

TABLE 2 Tensile Strength Requirements and Approximate Rockwell Hardness Values for Rolled Tempers

NOTE 1—Plate is generally available in only the as hot-rolled (M20) temper. Required properties for other tempers shall be agreed upon between the manufacturer and the purchaser at the time of placing the order.

Temper Designation		Tensile Strength, ksi[A] (MPa)[B]		Approximate Rockwell Hardness			
				B-Scale		Superficial 30T	
Code[C]	Name	Min	Max	0.020 in. to 0.036 in. (0.51 mm to 0.91 mm), incl	Over 0.036 in. (0.91 mm)	0.012 in. to 0.028 in. (0.30 mm to 0.71 mm), incl	Over 0.028 in. (0.711 mm)
				Copper Alloy UNS No. C40500			
M20	As hot-rolled	35 (240)	50 (345)	. . .	. . .	. . .	. . .
H01	Quarter hard	41 (280)	53 (365)	30-54	34-62	36-56	38-58
H02	Half hard	46 (315)	58 (400)	50-66	52-69	49-60	51-62
H03	Three-quarter hard	52 (360)	64 (440)	60-72	62-74	56-66	58-68
H04	Hard	58 (400)	70 (485)	66-76	68-78	60-68	62-70
H06	Extra hard	63 (435)	75 (515)	71-78	72-80	65-71	66-73
H08	Spring	68 (470)	80 (550)	75-81	76-83	67-72	68-74
H10	Extra spring	73 (505)	84 (580)	78-83	79-85	69-73	70-75
				Copper Alloy UNS No. C40810			
H02	Half hard	57 (395)	73 (505)	65-80	66-81	60-70	62-72
H04	Hard	76 (525)	88 (605)	78-89	80-90	67-74	69-75
H06	Extra hard	90 (620)	100 (690)	82-90	83-92	69-75	70-76
H08	Spring	94 (650)	102 (705)	85-92	86-94	71-77	72-78
				Copper Alloy UNS No. C40850			
H02	Half hard	57 (395)	73 (505)	65-80	67-81	60-69	62-72
H04	Hard	76 (525)	89 (615)	78-88	80-90	67-74	69-75
H06	Extra hard	90 (620)	100 (690)	82-91	83-93	69-75	70-76
H08	Spring	94 (650)	106 (730)	85-92	87-94	72-77	73-78
				Copper Alloy UNS No. C40860			
H02	Half hard	56 (385)	72 (495)	64-80	65-80	60-70	61-72
H04	Hard	74 (510)	87 (600)	77-89	79-90	66-74	68-75
H06	Extra hard	88 (605)	98 (675)	81-90	82-91	68-75	69-76
H08	Spring	92 (635)	105 (725)	84-92	85-94	70-77	71-78
				Copper Alloy UNS No. C41100			
M20	As hot-rolled	34 (235)	50 (345)	. . .	. . .	. . .	. . .
H01	Quarter hard	42 (290)	54 (370)	32-60	34-63	37-57	38-64
H02	Half hard	49 (340)	60 (415)	51-68	52-70	50-62	51-67
H03	Three-quarter hard	55 (380)	66 (455)	62-75	63-77	58-66	59-70
H04	Hard	61 (420)	72 (495)	68-79	69-81	62-70	64-71
H06	Extra hard	67 (460)	78 (540)	74-82	76-84	66-73	67-72
H08	Spring	73 (505)	83 (570)	78-84	77-86	69-74	70-73
H10	Extra spring	78 (540)	. . .	80 and over	80 and over	70 and over	71 and over
				Copper Alloy UNS No. C41300			
M20	As hot-rolled	37 (255)	50 (345)	. . .	. . .	. . .	. . .
H01	Quarter hard	45 (310)	55 (380)	34-62	35-64	40-58	39-60
H02	Half hard	50 (345)	62 (430)	52-70	53-72	51-63	51-64
H03	Three-quarter hard	58 (400)	68 (470)	64-77	66-78	59-68	60-69
H04	Hard	65 (450)	75 (515)	71-80	72-81	63-70	64-70
H06	Extra hard	70 (485)	82 (565)	77-83	78-84	67-71	68-72
H08	Spring	76 (525)	86 (595)	81-86	82-87	70-73	70-74
H10	Extra spring	81 (560)	. . .	85 and over	86 and over	72 and over	73 and over
				Copper Alloy UNS No. C41500			
M20	As hot rolled	38 (260)	50 (345)	. . .	. . .	. . .	. . .
H01	Quarter hard	46 (315)	56 (385)	48-73	49-75	48-65	49-67
H02	Half hard	53 (365)	63 (435)	68-78	70-80	62-68	63-70
H03	Three-quarter hard	57 (395)	68 (470)	73-80	75-82	65-70	66-71
H04	Hard	64 (440)	75 (515)	78-85	79-87	69-72	69-74
H06	Extra hard	70 (485)	82 (565)	81-87	82-90	70-73	70-75
H08	Spring	78 (540)	89 (615)	86-92	87-93	73-76	73-77
H10	Extra spring	85 (585)	. . .	89 and over	90 and over	74 and over	75 and over
				Copper Alloy UNS No. C42200			
M20	As hot-rolled	40 (275)	53 (365)	. . .	. . .	. . .	. . .
H01	Quarter hard	47 (325)	57 (395)	42-68	44-70	43-62	46-65
H02	Half hard	54 (370)	65 (450)	64-74	66-76	58-68	61-70
H03	Three-quarter hard	60 (415)	72 (495)	71-80	73-82	64-69	66-71
H04	Hard	67 (460)	79 (545)	76-83	78-85	67-71	69-73
H06	Extra hard	75 (515)	85 (585)	80-85	82-87	69-73	70-74
H08	Spring	82 (565)	92 (635)	83-88	85-90	70-74	71-75
H10	Extra spring	88 (605)	. . .	86 and over	86 and over	74 and over	74 and over
				Copper Alloy UNS No. C42500			
M20	As hot-rolled	40 (275)	54 (370)	. . .	. . .	. . .	. . .
H01	Quarter hard	49 (340)	59 (405)	46-71	48-73	45-65	47-67
H02	Half hard	57 (395)	69 (485)	67-81	69-83	63-69	65-72
H03	Three-quarter hard	62 (430)	74 (510)	74-84	76-86	66-71	68-73
H04	Hard	70 (485)	82 (565)	81-88	83-90	70-74	72-76
H06	Extra hard	76 (525)	88 (605)	86-92	88-94	71-75	73-77
H08	Spring	84 (580)	94 (650)	89-93	91-95	73-77	74-78